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Resection arthroplasty for failed shoulder arthroplasty

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Background: As shoulder arthroplasty becomes more common, the number of failed arthroplasties requiring revision is expected to increase. When revision arthroplasty is not feasible, resection arthroplasty has been used in an attempt to restore function and relieve pain. Although outcomes data for resection arthroplasty exist, studies comparing the outcomes after the removal of different primary shoulder arthroplasties have been limited.

Materials and methods: This was a retrospective multicenter review of 26 patients who underwent resection arthroplasty for failure of a primary arthroplasty at a mean follow-up of 41.8 months (range, 12-130 months). Resection arthroplasty was performed for 6 failed total shoulder arthroplasties (TSAs), 7 failed hemiarthroplasties, and 13 failed reverse TSAs.

Results: Patients who underwent resection arthroplasty demonstrated significant improvement in visual analog scale pain score (6 ± 4 preoperatively to 3 ± 2 postoperatively). Mean active forward flexion and mean active external rotation decreased, but this difference was not significant. Subgroup analysis revealed that postoperative mean active forward flexion was significantly greater in patients undergoing resection arthroplasty after failed TSA than after reverse TSA ($P = .01$).

Conclusions: Resection arthroplasty is effective in relieving pain, but patients have poor postoperative function. Patients with resection arthroplasty for failed reverse shoulder arthroplasty have worse function than those with failed hemiarthroplasty or TSA. Surgeons should be aware of this when assessing postoperative function. There is no difference in functional outcome between hemiarthroplasty and TSA.

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Arthroplasty of the shoulder has become an increasingly common procedure, and most outcomes are successful.[1,2] However, failure may occur due to mechanical failure, loosening, infection, or fracture.[26] The treatment depends on many factors, including the presence of infection, the quality and function of the surrounding musculature and soft tissues, the degree and location of bone loss, and the medical comorbidities and functional demands of the patient. In some instances, these factors may prohibit the reimplantation of a prosthesis. The use of reverse shoulder arthroplasty (RSA) to restore function has become increasingly common since its introduction by Grammont et al.[11,12]

However, the reverse total shoulder prosthesis presents a difficult problem when the construct fails because the options for revision of the shoulder are limited. Revisions are difficult because of the amount of bone loss from the glenoid and humerus, as well as the problematic soft tissue tension. In many patients with failure, resection arthroplasty may be the only acceptable intervention. In the few publications that have addressed outcomes of resection arthroplasty,[4,6,16,18,19,22] the results have shown that although the function of the shoulder is not improved compared with the patient's preoperative status, most patients do achieve significant pain relief. To our knowledge, none of these publications have compared the outcomes of patients undergoing resection arthroplasty after different types of failed shoulder arthroplasties, including RSA, total shoulder arthroplasty (TSA), and hemiarthroplasty.

We examined the outcomes after resection arthroplasty performed after failure of primary shoulder arthroplasty in a modern population and compared the outcomes for these patients based on their primary arthroplasty type: shoulder hemiarthroplasty, conventional TSA, and reverse TSA. We hypothesized that there would be no difference in functional outcome or pain relief achieved after resection arthroplasty based upon the type of arthroplasty that the patient had originally undergone. We also hypothesized that pain would be significantly improved after resection arthroplasty.[9,16,23]

Materials and methods

We identified 26 individuals (14 men, 12 women) who had undergone resection arthroplasty of the shoulder between October 1987 and July 2009 at 5 institutions. Inclusion criteria were patients aged 18 years or older, with minimum follow-up of 12 months, who had undergone a resection arthroplasty for failed arthroplasty of any type. Exclusion criteria were any patient aged younger than 18 years, follow-up of less than 12 months, and patients undergoing resection arthroplasty for any diagnosis other than failed arthroplasty.

Our cohort had a mean age 67 ± 11.5 years, with a mean follow-up of 41.7 ± 28.7 months (range 12-130 months). The indications for surgery and status of the rotator cuff and deltoid at the time of surgery are summarized in Table I. At the time of surgery, 7 patients had evidence of deltoid atrophy, and 1 patient had evidence of anterior deltoid detachment. Deep infection was the reason for resection arthroplasty in 22 patients (84.6%), and the remaining 4 patients had diagnosis of failed arthroplasty not due to infection, comprising 1 failed TSA secondary to instability, 1 failed TSA due to glenoid loosening, 1 failed RSA secondary to osteoporosis, and 1 failed hemiarthroplasty and inability to place RSA secondary to scar. Patient 26 had a pre-existing axillary nerve lesion. Two patients were involved in workers compensation claims.

Implants removed before resection arthroplasty included TSA in 6 patients, shoulder hemiarthroplasty in 7 patients, and reverse TSA in 13. For the purpose of group comparisons, the study population was subdivided with respect to the type of implant removed.

Data reviewed included physical examination findings with evaluation of range of motion, visual analog scale pain score (VAS), and Constant Shoulder Score (CSS).[7] Although the data were mostly complete, not all data were available for all patients.

Surgical technique

Patients were placed in the beach chair position for all resection arthroplasty procedures. All prior procedures had been performed through a deltopectoral approach, and this approach was used for the resection procedure. Once exposure of the glenohumeral joint was obtained, the shoulder was dislocated, and the polyethylene liner or humeral head was disengaged and removed. For removal of the humeral prosthesis, an extraction tool was attached to the humeral stem, and the component was backslapped to remove it from the humerus. If necessary, an osteotomy was performed to aid in extraction. Cement, if present, was curetted from the metaphyseal and diaphyseal regions of the humerus.

If the patient had a prior reverse TSA, the glenosphere was disengaged from the glenoid base plate, all screws were removed from the base plate–glenoid interface, and the base plate was removed from the glenoid. In patients with failed standard TSA, the glenoid component was excised from the glenoid and any remaining embedded pegs or keels were excised. All nonviable tissue was removed, and the shoulder was copiously irrigated.

At the end of the procedure, the wound was closed meticulously over a large drain. Postoperative rehabilitation protocol was followed according to the surgeon's preference (Table II).

Table I Status of rotator cuff and deltoid in the study cohort

Patient	Diagnosis	Rotator cuff status	Deltoid status
1	Infected/dislocated RSA	Rupture of Sup, Inf, Sub, TM	Atrophy of anterior, middle, and posterior fibers, but intact
2	Infected failed hemiarthroplasty	Rupture of Sup, Inf, Sub, TM	Atrophy of anterior, middle and posterior fibers, but intact
3	TSA glenoid loosening	Rupture of Sup	No atrophy, intact
4	Infected RSA	Rupture Sup, Inf, Sub	No atrophy, intact
5	Infected RSA	Rupture Sub	No atrophy, intact
6	Infected RSA	Rupture Sup, Inf	Atrophy of anterior deltoid fibers, but intact
7	Infected RSA	Rupture Sup, Inf, Sub	Deltoid atrophy, but intact
8	Infected HA	Intact	Atrophy of anterior deltoid fibers, but intact
9	Infected RSA	Massive rotator cuff rupture	No atrophy, intact
10	Infected RSA	Massive rotator cuff rupture	No atrophy, loss of insertion of anterior deltoid fibers
11	Infected RSA	Rupture Sup, Inf Sub	Atrophy of anterior deltoid fibers but intact
12	Infected RSA	No rupture	No atrophy, intact
13	Infected TSA	No rupture	No atrophy, intact
14	Infected TSA	Intact	No atrophy, intact
15	Infected RSA	Rupture Sup, Inf, Sub	No atrophy, intact
16	Infected RSA	Rupture Sup, Inf, Sub	No atrophy, intact
17	Infected RSA	Rupture Sup, Sub	No atrophy, intact
18	Infected hemiarthroplasty	Rupture Sup, Sub	No atrophy, intact
19	Infected TSA	Intact	No atrophy, intact
20	Infected hemiarthroplasty	Intact	No atrophy, intact
21	Infected hemiarthroplasty	Rupture Sub	No atrophy, intact
22	Failed RSA due to osteoporosis	Rupture Sup, Inf, TM	No atrophy, intact
23	Failed TSA due to instability	Rupture Sup, Inf, Sub	Atrophy of anterior deltoid fibers, but intact
24	Infected TSA	Rupture Sup, Inf, Sub	No atrophy, intact
25	Failed hemiarthroplasty	Unknown	Unknown
26	Infected hemiarthroplasty	Unknown	Unknown

FI, fatty infiltration; *Inf,* infraspinatus; *RSA,* reverse shoulder arthroplasty; *Sub*, subscapularis; *Sup,* supraspinatus; *TM,* teres minor; *TSA,* total shoulder arthroplasty.

Table II Surgeon-specific rehabilitation protocols

Surgeon	Rehabilitation protocol
1	Rehabilitation only for elbow, wrist, and hand range of motion with a home-directed program.
2	Sling for 2 months, with pendulum exercises starting on postoperative day 15. Gentle activities of daily living at 2 months. No formal rehabilitation or strengthening exercises.
3	Sling for 6 weeks. Remove sling at 6 weeks and start physical therapy, including full passive forward elevation, external rotation limited to 30°, and active range of motion as tolerated. Therapy advanced at 12 weeks to include full active and passive range of motion and strength advanced as tolerated.
4	Sling for 1-2 weeks. Passive range of motion at week 1, advanced to active range of motion at 2 weeks. Rehabilitation for elbow, wrist, hand range of motion.
5	Sling for 1-2 weeks. Passive range of motion advanced to active range of motion at 2 weeks. Rehabilitation for elbow, wrist, hand range of motion.

Statistical analysis

Variables are summarized using means ± standard deviations. Comparisons between groups used parametric measures, because the data were normally distributed. A Student *t* test was used for 2-group comparisons (CSS, VAS, active forward flexion, and active external rotation), and 1-way analysis of variance with Tukey method was used for multigroup comparisons of CSS, VAS, active forward flexion, and active external rotation among patients who had resection of hemiarthroplasty, TSA, and reverse TSA. SPSS software (IBM Inc, Armonk, NY, USA) was used for calculations, and the significance level was set to $P < .05$.

Results

Results of the group and subgroups with outcome comparisons are described in Tables III, IV, and V. No intraoperative complications were associated with the resection arthroplasty procedure. In the patients with prior infection, resection arthroplasty successfully eliminated the infection in combination with prolonged, targeted antibiotic therapy. The deltoid was intact in all but 1 patient. Patient 10 had a loss of insertion of the anterior fibers of the deltoid at the time of surgery.

Table III Overall functional results of patients

Variable	No.	Preoperative (Mean ± SD)	No.	Postoperative (Mean ± SD)	*P* (2-tailed test)
VAS pain score	22	6 ± 4	26	3 ± 2	.001*
Constant Shoulder Score	18	25.2 ± 15.8	21	27.3 ± 12.5	.69
Forward flexion, deg	16	60 ± 35	26	45 ± 30	.27
External rotation, deg	16	16 ± 22	26	9 ± 13	.50

SD, standard deviation; *VAS,* visual analog scale.
* Statistically significant ($P < .05$).

Table IV Differences in postoperative assessments and range of motion examined for significant differences using analysis of variance

Post-op assessment	No.	Mean ± SD	Min-Max	*P*
VAS pain score				
Hemiarthroplasty	7	3.6 ± 2.9	1-10	.63
TSA	6	2.3 ± 2.3	0-6	
Reverse TSA	13	3.3 ± 2.4	0-10	
Total	26	3.2 ± 2.5	0-10	
ASES score				
Hemiarthroplasty	3	40.3 ± 9.2	35-51	.93
TSA	4	38.3 ± 7.7	30-48	
Reverse TSA	4	38.3 ± 6.7	32-45	
Total	11	38.8 ± 7.0	30-51	
CSS				
Hemiarthroplasty	5	26.7 ± 17.8	3-53	.93
TSA	4	29.54 ± .0	24-33	
Reverse TSA	12	26.8 ± 12.7	11-53	
Total	21	27.3 ± 12.5	3-53	
Forward flexion				
Hemiarthroplasty	7	51.4 ± 21.4	30-80	.015*
TSA	6	71.7 ± 32.0	20-100	
Reverse TSA	13	32.7 ± 23.9	0-80	
Total	26	46.7 ± 29.1	0-100	
External rotation				
Hemiarthroplasty	7	7.1 ± 11.1	−10 to 20	0.34
TSA	6	15.8 ± 13.6	0-35	
Reverse TSA	13	6.5 ± 13.5	−20 to 30	
Total	26	8.9 ± 13.0	−20 to 35	

ASES, American Shoulder and Elbow Surgeons; *CSS,* Constant Shoulder Score; *Min,* minimum; *Max,* maximum; *SD,* standard deviation; *TSA,* total shoulder arthroplasty; *VAS,* visual analog scale.
* Statistically significant ($P < .05$).

Table V Tukey test examining differences in postoperative forward flexion among subgroups based on implant removed

Variable	Implant	Implant	*P*
Post-op AFF	Hemi	TSA	.338
		Reverse	.274
	TSA	Hemi	.338
		Reverse	.013*

AFF, active forward flexion; *Hemi,* hemiarthroplasty; *TSA,* total shoulder arthroplasty.
* Statistically significant ($P < .05$).

Pain relief was significantly improved for the entire study group, with average VAS pain scores decreasing from 6 ± 4 preoperatively to 3 ± 2 postoperatively ($P < .05$). The cohort was further subdivided into descriptive groups based on the type of prosthesis removed and analyzed for significant differences (Table IV). No significant difference was noted in pain relief among the hemiarthroplasty, standard TSA, or reverse TSA groups at final follow-up ($P = .63$).

The CSS improved slightly, from 25.2 ± 15.8 preoperatively to 27.3 ± 12.5 postoperatively; however, this was not statistically significant. There was no significant difference in CSS change among the hemiarthroplasty, standard TSA, or reverse TSA groups at final follow-up ($P = .93$).

The mean active forward flexion decreased for the cohort overall, from a score of 60° ± 35° preoperatively to 45° ± 30° postoperatively. This difference was not statistically significant ($P = .27$). There was a significant difference in postoperative mean active forward flexion between subgroups according to the type of prosthesis removed. The postoperative mean active forward flexion for the TSA group was significantly greater than that of the reverse TSA group ($P < .05$).

The mean active external rotation also decreased for the cohort as a whole, from 16° ± 22° preoperatively to 9° ± 13° postoperatively. This difference was not statistically significant. The average internal rotation improved by 0.5 levels at the time of final follow-up. There was no significant difference in loss of external rotation among the hemiarthroplasty, standard TSA, or reverse TSA groups at final follow-up ($P = .34$).

Discussion

The use of resection arthroplasty has become increasingly rare with the advances of modern medicine and technology.[23] Historically, indications for resection arthroplasty

have included septic arthritis with osteomyelitis,[5,8,9,24] fractures of the proximal humerus that cannot be reconstructed,[13,14,15,20,21,25] and recalcitrant symptomatic arthritis of the glenohumeral joint.[17] Modern alternatives in the treatment of these pathologies have limited the role of resection arthroplasty. However, with the development of the shoulder prosthesis and the complications associated with its use, resection arthroplasty is sometimes the only prudent choice to offer a patient if the prosthesis fails.

Previous reports on the outcomes of resection arthroplasty have been limited in their number and population size but indicate that pain relief is a predictable outcome of the procedure. Féry et al[10] reported minimal residual pain in 68% of the patients reviewed, which was similar to the results reported by Lettin et al.[16] Rispoli et al[23] reported significant pain relief in 18 patients studied in their retrospective review, with mean pain scores improving from 8.8 to 4.5. Of these patients, 44% required no analgesic medications, 22% required anti-inflammatory medications, and 33% required narcotic medications for pain control. Braman et al[3] reported narcotic use in only 1 of 7 patients after resection arthroplasty for an infected prosthesis. In our study population, the mean preoperative VAS pain score was 6 ± 4 preoperatively, and this improved significantly to 3 ± 2 postoperatively ($P < .05$). On the basis of the results of our study, as well as the findings of others, resection arthroplasty appears to be an effective salvage operation for the improvement of shoulder pain but not function.

Range of motion associated with a resection arthroplasty has varied in the limited reports available. Braman et al[3] reported an average forward flexion of 28° and an average external rotation of 8° in 7 patients after resection arthroplasty. Rispoli et al[23] reported better outcomes in their 18 patients, with mean active forward flexion of 70° and mean external rotation of 31°. This represented a significant postoperative improvement in active forward flexion but not in external rotation. Our studied group achieved mean active forward flexion of 45° and external rotation of 9°. These values are in line with previous studies, and neither represented a significant change from preoperative levels. It is possible, based on our data, that these outcomes of resection arthroplasty after failed shoulder arthroplasty are similar to those achieved after resection arthroplasty performed for fracture or infection. However, we did not directly investigate this.

Analysis of functional assessment revealed that there was no significant improvement in the CSS ($P = .69$) in our patients. The CSS takes into consideration pain, activities of daily living, range of motion, and strength.[7] With no significant improvement in CSSs, our study seems to suggest that even though pain is improved, there is minimal overall functional improvement with resection arthroplasty. It is important to note that the reverse TSA group significantly worse loss of active forward elevation than the hemiarthroplasty or TSA groups. Patients who undergo resection arthroplasty for failed reverse TSA have minimal remaining musculature to maintain a functional shoulder; therefore, that this subset of patients would have worse active forward elevation is not surprising.

One patient in our cohort (patient 10) had a loss of anterior deltoid insertion at the time of surgery. This patient had a decrease in preoperative to postoperative active forward elevation of 30° to 20°, but was not significant. The difference in motion is comparable to clinical outcomes observed in this cohort. Patient 26 had an axillary nerve injury before resection arthroplasty, and significant difference in postoperative range of motion was noted. Finally, subgroup analysis of 7 patients with deltoid atrophy at the time of surgery demonstrated no significant difference in postoperative range of motion or constant compared with those with a normal deltoid.

Limitations of our study relate to its retrospective nature as well as its small and varied numbers in the patient subsets. However, because resection arthroplasty after primary shoulder arthroplasty of any type is rare, we believe our multicenter design is a strength that adds weight to our findings. Because this was a retrospective study, we were unable to make additional subgroup analyses according to operative differences or findings that were not reported in the case notes. Outcomes reported in prior studies included an analysis by Rispoli et al[23] to evaluate outcomes based on the level of resection on the proximal humerus. Their subgroup analysis found no difference between patients whose humeri were resected at different levels in relation to the tuberosities. We did not evaluate this as a possible factor influencing outcome.

Conclusion

Resection arthroplasty appears to be an effective palliative treatment but with poor postoperative function. However, patients maintain at least some motion after resection arthroplasty for failed primary arthroplasty of any type. Resection arthroplasties performed for failed reverse TSA have worse functional outcomes than those performed for failed hemiarthroplasty or TSA. This is an important distinction that surgeons should be aware of when examining postoperative outcomes.

The increased use of shoulder arthroplasty techniques has greatly improved the function of patients with debilitating shoulder pain. With increased use, however, comes the inevitable increase in complications associated with the procedures and questions regarding their ideal management. Failed shoulder arthroplasty presents significant difficulties in maintaining patient function, and in addition to managing any associated infection and dealing with soft tissue and bony damage or loss, the overall health of the patient and the morbidity associated with repetitive surgical procedures must be considered. For this group of patients, resection arthroplasty is

a simple procedure that allows some maintenance of function and significantly reduces shoulder pain.

Disclaimer

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